

**GEOCONSERVATION RELATED TO IMPACT STRUCTURES.** W. U. Reimold and N. Hauser, Institute of Geosciences, Laboratory of Geochronology and Isotope Geology, Universidade de Brasília, Brasília, DF, Brasil ([wolf.uwer@gmail.com](mailto:wolf.uwer@gmail.com), [nataliahouser77@gmail.com](mailto:nataliahouser77@gmail.com))

**Résumé:** Nous présentons un aperçu des efforts de géoconservation et de sensibilisation liés aux structures d'impact, dans de nombreux pays du monde. Il ya des projets formidables, mais aussi des cas problématiques.

**Introduction:** Over the last 50-60 years, impact cratering has become a mainstream part of both the geosciences and planetology. The terrestrial record of confirmed impact structures has grown to over 200. In many parts of the world learners in high schools and students at university are now hearing about impact structures. However, this is not the case everywhere – and certainly not in large parts of Africa, Asia and South America.

**The status of global impact outreach:** Besides the large Natural History Museums that all have sections on Earth and Planetary Science, including introduction to impact cratering in terrestrial and planetological contexts, there are several well established and widely known impact crater-based outreach facilities. This includes the Ries Crater Museum in Nördlingen and Meteor Museum in the Steinheim impact crater (both in the South of Germany), as well as the Museum/Visitor Center at the world-famous Meteor Crater in Arizona. These museums are visited annually by many thousands of national and international visitors. The museum at Meteor Crater has been the hallmark of the Barringer Crater Company, and the Barringer Family Fund has been a staunch supporter of impact cratering research for decades. Besides these long-standing successes, there have been valid outreach efforts in many other parts of the world. We will highlight them here – looking at both the positive and negative cases.

Impact structures are unique experiences, where you may get this special feeling of being in an otherworldly place. Together readily available views of impact structures on the Moon, for most of us the closest we ever get to feeling the “planetary” realm is in an impact structure. These structures may provide unique opportunities to experience the “magic of nature” – the specific nature of the site itself, sometimes incredible landscapes, and the result of the often referred “most fundamental” process in the solar system. Impact structures can serve education about not only impact processes and outcomes, but also about astronomy, local and regional geology, mineralogy and geochemistry, geophysics, geography, and environmental science, socio-political aspects and cultural history, paleontology, sometimes mining geology, and biology, and always about the people living in a specific region or at this site. Thus, impact structures provide a unique integration of experiences from highly diverse disciplines. An impact structure may house a museum, or just some exhibits or signs,

geo- or ecotrails, camp-sites, astronomical facilities, or a hotel or even urban infrastructure – in essence, varied environments that can cater for varied clienteles (visitor groups and those maintaining the facilities). Despite their general rarity, a considerable number of impact structures is located close to populated areas, thus inviting regular visits from school groups as well as day or weekend visitors of all sorts. There are also amazing, entirely unexpected marvels in the “outback”, such as the gem of a nature park at Campo del Cielo in a rather remote part of Chaco Province of northern Argentina.

There are two highly successful impact museums in Europe – the Ries Crater Museum (RCM) and the Meteor Crater Museum in Sontheim in the Steinheim Basin structure. The RCM has been the centerpiece of the National Geopark Ries for 15 years. Just recently, on 13 April 2022, this geopark has become certified as a UNESCO Global Geopark. There are also notable developments by provincial/municipal authorities at Rochechouart, France, with a small but well-appointed museum (some 5,000 visitors p.a) in the homologous town. A major impact studies and heritage project, CIRIR, has, for the last years, not only contributed to the protection and promotion of the patrimony of the Rochechouart impact structure but also actively fertilized impact research. A large number of other European outreach initiatives are laudable in Norway (Gardnos), Sweden (e.g., Dellen, Lockne, Siljan), Finland (Karikkoselkä, Keuruselkä, Lappajärvi, Saarijärvi, Söderfjärden, Summanen), at the Kaalijärvi crater in Estonia, and in the Morasko Meteorite Park, Poznan, Poland.

Meteor Crater Museum / Barringer Crater National Landmark in Arizona is unbeatable in visitor numbers. Two independent sources informed in 2018 that not less than 270,000 visitors came to Meteor Crater that year. The Museum, guided tours, the perfectly sized and preserved, young crater manage to fuel a visitor’s imagination. A second, smaller but well-run visitor center exists at Odessa crater in Texas. It also seems that there is some development of outreach facilities at Wetumpka crater, Alabama.

In Canada, the large Sudbury Structure is well represented at Science North in the town of Sudbury, just opposite of a marvellous shatter cone outcrop at Ramsay Lake Road. A dedicated impact cratering outreach resource is kept at the Centre for Planetary Science and Exploration, University of Western Ontario, which

includes a database on terrestrial impact structures ([www.impactearth.com](http://www.impactearth.com)). For several decades, the University of New Brunswick in Fredericton, New Brunswick, Canada) has hosted the Earth Impact Database, which has been an indispensable resource for researchers and laymen alike.

On the negative side, the impact conservation situation in South Africa is rather dire. Since the late 1980s efforts have been made to develop an outreach facility/museum at Tswaing crater. Temporary exhibits were developed, nature-trails maintained, and signage procured for major outcrops. At the beginning of the 21<sup>st</sup> century, a nice, crater-shaped museum building was erected, and one waited for the equipment of this place with a permanent exhibition. Instead, procrastination took over, and in 2009 the building was partially destroyed by arson. No further development has taken place there since. Hiking-trails are partly overgrown and signage has been neglected. The only publication on Tswaing, prepared in the 1990s for the public, was essentially wasted when the large stock of remaining copies was given away by the Council for Geoscience as freebies to local primary schools. In conclusion, a poor record of mismanagement and misdevelopment indeed.

A sizable part of the world's largest known impact structure, Vredefort in South Africa, was declared a World Heritage Area by UNESCO as far back as July 2005. Hectic development mainly by private developers/landowners ensued, who frantically invested before a presumed halt for such activities would be imposed, or to take advantage of an expected tourism boom. Government agencies at national and provincial levels, as well as property owners and landowner associations have continued to bicker about legal aspects. The national government showed complete incompetence in stewardship and failed to declare the Vredefort Dome a National Natural Heritage site, the first requirement on the way to make the World Heritage declaration effective. Some 10 years ago, a large visitor center was erected on a prominent hill, together with ample space for souvenir markets to kickstart a local arts-and-crafts industry. The participants in the Large Meteorite Impacts IV conference at Vredefort in 2008 attended the official inauguration of this site and donated a large number of impact and meteorite specimens for the planned museum. The place, however, was never opened and became derelict due to recognition of seriously faulty construction, followed by partial collapse. On the positive side, a comprehensive natural heritage book about the Vredefort Dome and impact cratering in general by W.U. Reimold and R.L. Gibson was a major success with wide dissemination of information about impact cratering in 3 editions. Lately, a 1-room exhibit about Vredefort has been set up in the local museum in Parys town.

Since the onset of the successful 2004 ICDP drilling project at Bosumtwi, Ghana, the development of an outreach facility on the rim of this young and impressively preserved impact structure has been discussed. Still, to date, this plan has remained on the drawing-board. And yet, there is one positive development in Africa: The Attarik Foundation of Morocco has developed a sizable planetary science display in Casablanca that includes highly informative exhibits about meteorites and meteorite impact. Since mid-2021, this exhibition has been seen by many thousands of visitors from all sectors of society.

A single effort is known to us from Asia. Already in 2016, the Dhala impact structure was selected as one of 40 Geotourism Hotspots on the Indian Subcontinent by the Geological Survey of India. Recently, a proposal for a Dhala Impact Cratering and Planetary Science Museum was submitted by Jayanta Pati to the Government of Madhya Pradesh State.

South America now boasts a record of 11 confirmed impact structures and sites of large meteorites. Since 2004 efforts have been made to have the largest impact structure on this continent, 40-km-diameter Araguainha Dome in Brazil, recognized as a National Geopark. As the structure is located 100s of km from large population centers and lacks tourism infrastructure, this is not an easy target for visitor attraction. However, with refurbishment of the road through the structure to be completed in 2022, there is now an opportunity to develop signage for public information. The second area of note on this continent is the Campo del Cielo meteorite park in Chaco Province, Argentina. This area boasts a marvellous outreach facility - a provincial park that informs about meteorites, impact cratering, the key workers on this strewn field, and cultural aspects. The park provides excellent (though somewhat weathered) signage about the exceptionally large meteorites on display and regional botany. Together with an annual outreach and cultural festival, the park is said to draw some 12,000 visitors p.a..

In Australia, several museums (e.g., in Melbourne or Perth) present excellent exhibits about History of the Solar System, Earth Evolution, Meteorites, and Impact Cratering. In addition, there is good interpretative signage for lay-people at Gosses Bluff, at the Henbury craters, and at Wolfe Creek.

**Conclusions:** Besides the outreach facilities of note, there remains much potential for further education and outreach at many impact structures worldwide. A number of members of the impact cratering community is hard at work promoting science, in general, and impact cratering studies, in particular. We are dealing with a hugely attractive resource - planetary science, which has enormous potential to fire the imagination of the public, especially of children.

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